Citation:

Bergsma NJ, Fischer ARH, Van Asselt ED, Zweitering MH, De Jong AEI. Consumer food preparation and its implication for survival of *Campylobacter jejuni* on chicken. *Br Food J.* 2007; 109: 548-561.

Study Design:

Cross-sectional study and laboratory inactivation experiments.

Class:

D - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

NEUTRAL: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

- To determine whether the predominant method of heating poultry meat by Dutch consumers effectively reduced *Campylobacter jejuni* contamination
- To investigate how the most commonly consumed type of chicken meat was generally prepared, to estimate safe cooking times for this cooking method and to assess consumer's methods to check doneness.

Inclusion Criteria:

For survey: Inhabitant from the Utrecht area (fourth largest city in The Netherlands), in phone book for the area.

Exclusion Criteria:

For survey: Not an inhabitant from the Utrecht area (fourth largest city in The Netherlands), and not in phone book for the area.

Description of Study Protocol:

Survey Component

Recruitment

Inhabitants from the Utrecht area (fourth largest city in The Netherlands) were randomly drawn from the phone book.

Design

- A survey was conducted on self-reported behavior asking about chicken breast fillet preparation, psychological constructs and demographic characteristics
- Questions on self-reported behavior related to two important stages in consumer food handling: Purchase and preparation of chicken meat
- Three psychological constructs were measured: Perceived control (to what amount do you

think you yourself can prevent from falling ill after eating chicken meat), optimism and worry about pathogens in chicken meat (I am concerned about the quality of chicken meat; news about foodborne pathogens worries me)
- Demographics included gender, year of birth and highest completed level of education
- The survey consisted of 82 questions and took about 15 minutes to complete
- All items were rated on a five-point scale
- Most were anchored at “never” and “very often”
- Optimism items were anchored at “highly unlikely” and “highly likely” and the worry items anchored at “completely disagree” and “completely agree”
- There were two open-ended questions: One with regard to arguments why thorough cooking of chicken meat is (or is not) important, the other asking which bacteria present on chicken breast fillet that participants were familiar with
- The questionnaire was mailed March 2005. To increase the response rate, five gift checks of 10 euro were awarded to randomly selected participants who sent back a completely filled questionnaire within the appointed time period.

Statistical Analysis

- The significance level used was P=0.05
- For not normally distributed data (tested using Kolmogorov-Smirnov), non-parametric tests (Wilcoxin T, Mann-Whitney U, and Spearman correlation) were used
- Data that were normally distributed were analyzed using ANOVA and T-tests
- Answers to a question about the importance of thorough cooking were classified into categories: Illness, taste, bacteria, and miscellaneous.

Microbiological Component

Design/Intervention

- C. jejuni strains NCTC 1168, NCTC 11828, B258, LB99hu and 82/69 were used in a five-strain cocktail
- The whole fillets were inoculated (108-9 CFU/fillet) and stored (overnight, 4°C)
- In addition, diced fillets were used. Fillets were cut into pieces of approximately 1cm by 1cm by height of fillet, packed in a bag, inoculated with 1ml strain cocktail and stored (overnight, 4°C)
- For heat-inactivation tests, a casserole was used, which was heated on the second largest burner of a domestic gas stove
- Fillets were fired according to recipe direction of cookbooks
- A total of 10g of margarine were heated at high flame until skim disappeared before adding chicken breast fillet
- After melting the margarine as such (two minutes), the inoculated fillets were added (one fillet per measurement) and fried over high heat for two minutes (each side one minute; maximal gas flow) to sear the meat, followed by frying over medium size burner at minimal gas flow
- The minimum burner heat is assumed to be a reasonable estimate of the situation at home as higher settings of the burner tended to result in burnt meat
- After searing the fillets, they were first fried on one side, and turned halfway the remainder of the cooking time
- Turning was done using sterile utensils that were changed for each time the fillets were handled
- Cooking times at minimal gas flow ranged from zero to 13 minutes, resulting in total

cooking times, including searing, between two and 15 minutes
- After frying, chicken meat was immediately sampled for enumeration of surviving C. jejuni cells.

Statistical Analysis

- Data were represented as count data (log CFU per fillet) plotted vs. frying time (minutes), to which a linear and Weibull inactivation models were fitted, taking levels below the detection limit into account with maximum likelihood estimation assuming Poisson distributions
- The best fitting model was determined by applying an F-test comparing the RSS of the Weibull and linear model
- In order to compare pooled data with individual experiments, an F-test was performed on the slope and intercept of log N per fillet and time (α=0.05).

Data Collection Summary:

Survey Component

- *Timing of measurements:* Not applicable. Cross-sectional survey
- *Dependent variables:* Responses to questions of the survey.

Microbiological Component

- *Timing of measurements:* Meat surface temperature was taken every 15 seconds during cooking, and bacterial enumeration occurred after cooking was complete
- *Dependent variables:*
  - Temperature of the surface of the meat [which was followed in time (every 15 seconds) using a thermocouple (PT100 type CS, Catec, The Netherlands) and data logger (logger type 1026 series number KF 9714003, Grant Instruments)]
  - Bacterial count in chicken meat (After frying, chicken meat was immediately sampled for enumeration of surviving *C. jejuni* cells; contamination levels of fillets were determined by use of the Most Probable Number (MPN) method in combination with spread-plating suitable dilutions on agar plates; suspected colonies of *C. jejuni* were confirmed by phase contrast microscopy; when both MPN and plate count results were available, plate counts were used. When the count was below 30, results from the MPN method were used).
- *Independent variables:* Cooking times varied from a total of two to fifteen minutes.

Description of Actual Data Sample:

Survey Component

- *Initial N:* 1000 survey questionnaires were mailed
- *Attrition (final N):* 290 questionnaires were returned; of those, 284 were usable
- *Age:* Mean 48, standard deviation ±14 years
- *Ethnicity:* All Dutch
- *Other relevant demographics:* Women were 74% of the sample. The majority (71%) lived together or were married.
- *Location:* Utrecht area (fourth largest city in The Netherlands).

Summary of Results:

Key Findings

Microbiological Component

- The number of *Campylobacters* recovered from fried chicken meat declined with increasing frying times and started to drop below detectable levels after nine minutes and three minutes frying to whole chicken breast fillet and dices, respectively
- The chicken meat was visibly checked for doneness. When fried as a whole, meat looked done after ten minutes, while dices took four minutes.
- The meat surface temperatures recorded varied widely between and within experiments
- For experiments conducted with whole fillets, mean meat surface temperature per experiment varied between 105°C to 167°C, with standard deviations ranging between 3°C to 18°C
- Pooling all data resulted in an overall mean meat surface temperature of 127°C with standard deviation 18°C
- For diced fillet, similar results were obtained (mean overall meat surface temperature 109°C±17°C).

Other Findings

Survey Component

- Among differently reported preparation methods of chicken breast fillet [$F(10,238)=159$, $P<0.001$], the most predominant were stir-frying and frying
- Cutting up chicken breast fillets was a fairly frequent practice (M=3.6) for everyone
- Thoroughly heating chicken breast was generally perceived as very important (M=6.8, seven-point scale). Women viewed this as more important than men [$U(277)=5,942$, $p<0.001$], and higher-educated participants tended to rate it as less important ($RS=-0.19$, $P<0.01$)
- When asked to list why thoroughly heating chicken meat is important, 15% mentioned improvement of taste. The most often mentioned reason was killing bacteria (73%), although 23% of the participants were less specific in stating that inadequate heating could cause illness and 3% reported other reasons
- The majority (81%) of the participants could mention names of bacteria present on chicken breast fillet. Among all participants, *Salmonella* was mentioned most frequently (79% of all participants, which amounted to 97% of the participants who indicated knowledge of bacteria); *Campylobacter* was only mentioned by 11 participants (4.3%)
- The most frequently used checking method was cutting open fillets to check the color of the inside of the meat
- No differences were observed among participants' demographics related to checking doneness
- Participants thought that a meal prepared by themselves was less likely to cause foodborne disease than a meal prepared by others
- Participants who reported a higher level of control, rated the importance of heating adequacy higher ($RS=0.15$, $P<0.05$). There was little worry about safety of chicken meat (M=3.2).
- A correlation was observed between worry level and the practice to check cooking adequacy by cutting chicken breast open ($RS=0.33$, $P<0.001$), and the importance of checking heating adequacy ($RS=0.18$, $P<0.01$)
- The higher the scores of optimism, worry and perceived control, the more emphasis was put

on the important issue of heating adequacy; however, the effect sizes were small.

Author Conclusion:

- Consumers tend to verify heating adequacy by visual inspection of the inside of the meat. However, microbiological experiments showed that although fried chicken breast fillets looked done, not all *C. jejuni* cells may be inactivated
- While taste was prominent during purchase, the more dominant concern in relation to preparation of chicken breast fillets was health, in which heating was seen as an important way to get rid of bacteria
- As recommended cooking times on meat package labels were shown to be only marginally safe, these might be considered to be adapted.

Reviewer Comments:

- *Blinding was not applicable to the survey portion of the study. However, the article did not mention if, during the microbiological component, investigators conducting the MPN method and agar plating were blinded to the frying time of the chicken homogenate*
- *Use of a standard household cook top in experiment may not be applicable to all populations and a gas cook top may have different heating properties than an electric cook top, and therefore, cooking times may need to vary*
- *Although frying was most popular cooking method, it may have been beneficial to study the C. jejuni inactivation with other cooking methods. It may be useful to compare the cooking time with complete inactivation for more methods than whole breast fillet frying and diced fillet frying.*

Authors noted that these limitations affected limit the scientific interpretation of their data:

- *Use of whole chicken breast fillets (as opposed to homogenous meat samples) purchased on different dates increased variability of the samples*
- *Variability in water content of fillets may have affected the surface temperature of the meat and thus increased variability in bacterial survival.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions		
1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes

3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions

1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	???
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	???
2.2.	Were criteria applied equally to all study groups?	N/A
2.3.	Were health, demographics, and other characteristics of subjects described?	No
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	N/A
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	N/A
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A

3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	No
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	No
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	No
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	No
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	Yes
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	N/A
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	No
6.6.	Were extra or unplanned treatments described?	No

6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	N/A
8.6.	Was clinical significance as well as statistical significance reported?	No
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	???
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	No
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes

10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes